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TRANSMITTAL

TO: Jennifer Fitch, PE Project Manager Vermont Agency of Transportation	DATE	PROJECT NO.
	8/6/2014	Brookfield BRF FLBR (2)

XX WE ENCLOSE THE FOLLOWING: ______ UNDER SEPARATE COVER WE ARE SENDING THE FOLLOWING

COPIES	NUMBER	DESCRIPTION	CODE
1		FRP Fabrication NCR 2 - Response to Aug 4th Meeting	H
1		Foam Billet Placement Procedure	H
1		Floating Span Length Procedure	H

CODE:

A FOR INITIAL APPROVAL
B FOR FINAL APPROVAL
C APPROVED AS NOTED-RESUBMISSION REQUIRED
D APPROVED AS NOTED-RESUBMISSION NOT REQUIRED
E DISAPPROVED-RESUBMIT
F QUOTATION REQUESTED
G APPROVED
H FOR APPROVAL
I AS REQUESTED OR REQUIRED
J FOR USE IN ERECTION
K LETTER FOLLOWS
L FOR FIELD CHECK
M FOR YOUR USE

BY: Paul J Halloran

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August 6, 2014

Mr. Paul Holloway
Miller Construction, Inc
PO Box 86
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Brookfield BRF FLBR (2)

Dear Mr. Holloway:

As a result of some production issues identified during fabrication of Pontoon 2, Kenway requested approval of nonconformance items and/or associated corrective action identified in Kenway letter dated July 28, 2014. Subsequently, T. Y. Lin recommended, and VTrans issued, a stop work order until the issues could be further evaluated and the path forward better understood. This letter forwards additional information requested in T. Y. Lin letter dated July 31 and items discussed during a site visit/meeting at Kenway on August 4.

Vertical Wall Alignment

(NCR 2, Items 1 and 3)

<u>Non-conformance</u>

The total out-of-plane displacement as measured using a taught string from one end of the pontoon to the other shows an average deviation of 1/16 in. with a maximum of 1/8 in. along the midline (centered on the rod holes) and a typical deviation of 1/8 in. with a maximum of 1/4 in. along the top (free) edge of the vertical wall. At this point, the two specification tolerances that we interpret as applicable to the vertical wall issue are 1) flatness: ±1/16 in. over 48 in. and 2) sweep: ±1/8 in. over the pontoon length. Currently, there are a few locations on Pontoon 1 and 2 that exceed the ±1/8 in. sweep criteria.

<u>Root Cause</u>

The source of the movement along the vertical wall relative to the desired, as-molded condition is due to shrinkage of the resin during cure, which is causing "pulling" in the radius at the base of the wall.

<u>Resolution</u>

The following steps are recommended to mitigate the amount of pulling in the vertical wall when fabricating Pontoons 3 through 10.

1. Various fabric placement techniques and material compaction tools have been investigated and are being employed to reduce bridging in the radius along the vertical wall to floor junction. In addition, a foam fillet is being placed above the release film under the vacuum bag to use vacuum pressure to help compact fabric in the relatively tight 1/2 in. mold radius. Eliminating excess resin in the radius will mitigate shrinkage and, therefore, reduce anticipated pulling.

2. The fabrication schedule will be shifted so that vacuum will be released from the hull approximately 65 hours after infusion instead of only 6-12 hours prior to de-molding. This will be accomplished within the schedule by shifting hull infusion to Friday (rather than Wednesday) and allowing the hull to cure over the weekend. The longer the part is allowed to cure while being held in place by vacuum, the closer the de-molded part will match the mold.

3. Prefabricated foam billets will be placed in the mold and spray foam installed in the 2-1/2 in. gap between adjacent bulkheads. (This process is detailed in the attached enclosure.) The walls will be temporarily braced during installation. It is believed that the smaller volume of pour in place foam – especially if slightly restrained during placement to build pressure – will help to maintain the desired form better than a large foam pour that results in considerable shrinkage.

The following justification is provided for accepting Pontoons 1 and 2 as related to the vertical wall issue.

1. Flatness, squareness, and sweep of the vertical wall below the midline (lower third) for Pontoons 1 and 2 are well within specification.
2. These same criteria are satisfied along the midline (middle third) for Pontoon 2 and only 5 feet in the end bay of Pontoon 1 exceed the sweep criteria by up to 1/8 in.
3. The top edge (upper third) of Pontoons 1 and 2 still meet flatness criteria. Only the upper edge within the center third to half of each bay (between transverse bulkheads) exceeds the ±1/8 in. requirement by up to 1/4 in.
4. Assuming the area exceeding the currently defined tolerances is 25% of the wall and the average thickness of additional infused laminate required to satisfy sweep criteria is 3/16", the additional weight added to achieve tolerances would be approximately 70 lb on Pontoon 1 and less on Pontoon 2.

Timber Bracing

(NCR 2, Item 2)

<u>Non-conformance</u>

Wood 2x4 bracing was utilized during foaming operations in Pontoon 2 in order to hold the vertical wall against the mold while the foam was placed and while it cured. The addition of this material, which was not included in the approved fabrication plan, was not submitted to the Agency for review and approval prior to leaving inside the foam.

<u>Root Cause</u>

Kenway acknowledged during the onsite meeting that leaving bracing material in the pontoon was well intentioned, but not pursuing proper approval was in error. The decision to leave the bracing in place was driven by the desire to improve the mating surface for the adjoining pontoons given that attempts during fabrication of Pontoon 1 to rely on foam pressure alone to hold the wall were unsuccessful due to foam shrinkage.

<u>Resolution</u>

Moving forward on the remaining pontoons, Kenway will take steps to utilize only temporary bracing as needed during foam installation to restore vertical walls to a plumb condition. No additional bracing will be permanently installed in any pontoon without first requesting approval from VTrans.

Kenway provides the following justification for requesting acceptance of Pontoon 2 with the wood bracing remaining in place.

1. The timber is encased in foam in a watertight pontoon and is therefore highly unlikely to experience rot or decay over the lifetime of the structure.
2. The amount of foam displaced by the wood bracing is approximately 30 ft^3 out of a total volume of 1,500 ft^3, or 0.2% of the foam volume.
3. The wood bracing provided temporary restraint to the vertical wall bending until the foam cured and became rigid. No additional stresses are imposed, nor are the braces acting as a structural member.

Hull Length

(NCR 2, Item 4)

Nonconformance

Kenway measured the first pontoon after being out of the mold for just over one week. The overall length of the "short" side of the end pontoon when measured at 70°F is 613-1/2 in., which is equal to the lower tolerance limit. The same measurement was obtained from Pontoon 2 one week after it was infused. When this length is adjusted to 40°F using the measured CTE of 8.76 in/in/°Fx10^{-6}, the overall length is reduced by 0.16 in. or just over 5/32 in., which brings the overall length of Pontoons 1 and 2 just outside of the required tolerance.

Root Cause

Pontoon length was carefully set in the mold using removable inserts at the exact distance noted in the drawings. However, resin shrinkage during cure – even in high fiber content laminates – causes the part dimensions to shrink proportionally to the degree of cure. The impact of this shrinkage was not fully anticipated while developing the fabrication process.

Resolution

Kenway proposes that part length in the mold be increased by moving the mold inserts outward 1/4 in. on each end for Pontoons 3 through 8. (Placement of the jog end inserts for Pontoons 9 and 10 may be adjusted further depending on cumulative tolerance stack up.) The ensuing part shrinkage will place the overall length back to within 1/8 in. of the temperature corrected design length, which is well within the specified tolerance.

Regarding the under length condition of Pontoons 1 and 2, Kenway and Agency representatives at the onsite meeting agreed that adding hand laid laminate to the ends of the hull would provide no benefit or structural equivalence. Therefore, Kenway proposes no modifications to the first raft and instead recommends the enclosed Floating Section Length Procedure be followed to ensure the overall floating span, which is a critical design element, falls within the desired tolerance of ±1/2 in. at 40°F. The relative dimensional tolerances between Pontoons 1 and 2 are satisfied.

Additional Comments

Kenway requested clarification on which nonconformance items required notification to, and approval from, the Agency prior to rectifying. The Agency requested that all items be brought to their attention for tracking and trending purposes and repairs falling within the approved scope would be quickly approved. Kenway also reiterated that as-built documentation is being completed for every pontoon, which includes overall dimensions and thickness, offset distances along the pontoon mating surface, and the location and extent of any repairs or deviations.

Sincerely,

Jacob Marquis

Jacob Marquis, P.E.

Senior Project Engineer

Enclosures:

(1) Foam Billet Placement Procedure

(2) Floating Span Length Procedure

Foam Billet Installation Procedure

Prepared by:

Jacob Marquis

Kenway Corporation

August 5, 2014

1.0 Purpose

This procedure documents the process for installing prefabricated 2 pcf foam blocks, specifically ELFOAM P200 polyisocyanurate from Elliot Foam.

2.0 Safety

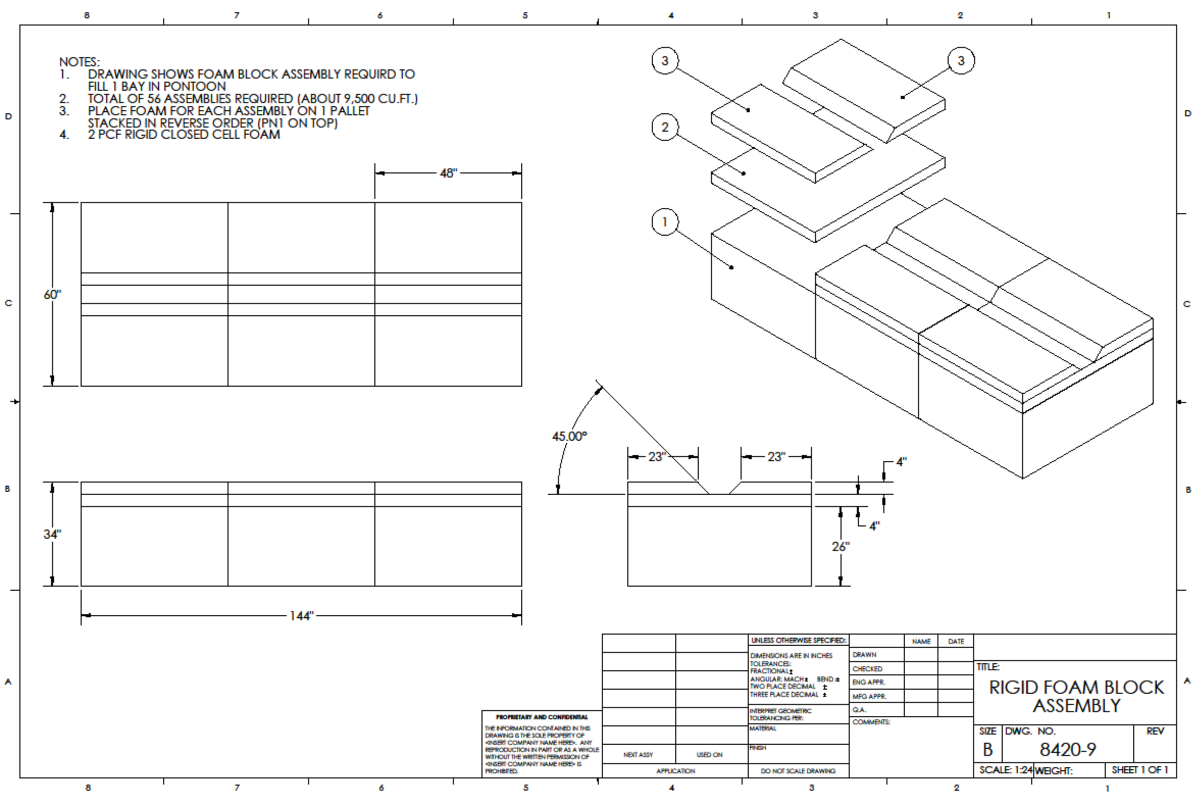
2.1 Follow approved procedures and wear appropriate PPE when installing pour in place foam.

2.2 Be cautious around machinery and wear proper PPE when cutting foam billets.

3.0 Execution

3.1 Ensure each bay in the pontoon is free of debris and generally clean.

3.2 Gather the necessary components of the foam assembly as shown below in Drawing 8420-9.



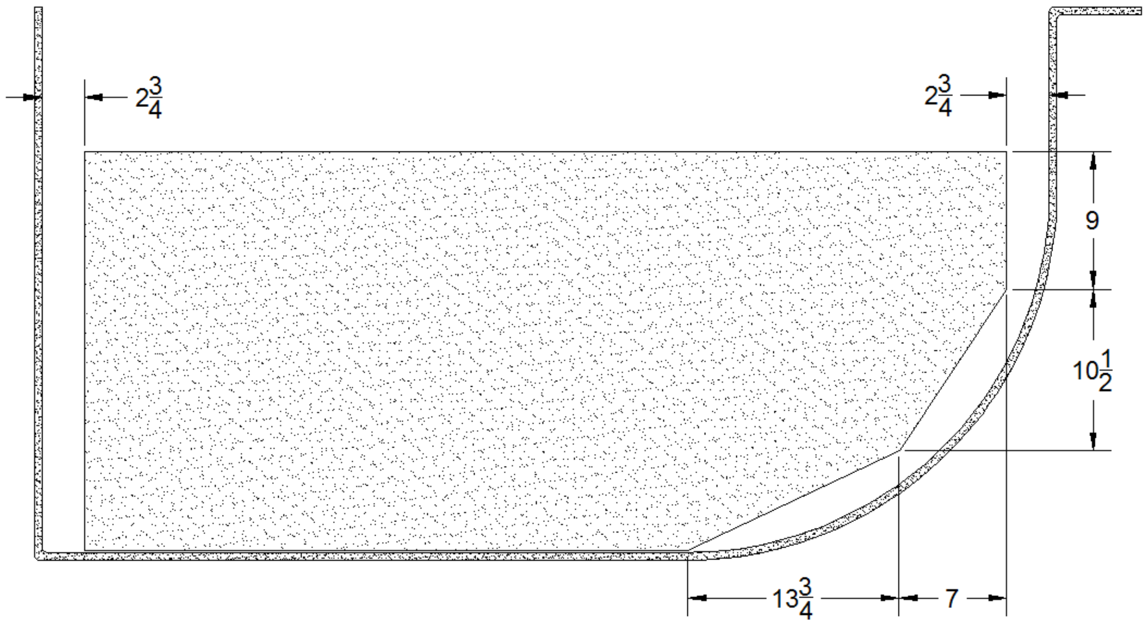
3.3 Apply a layer of MA590 adhesive on the bottom of the 26” thick block using a 1/4” x 3/16” V-notch trowel held at approximately a 45 degree angle.

3.4 Place the block firmly onto the pontoon floor moving the block back and forth slightly while applying pressure prior to settling in on the desired location.

3.5 Repeat Steps 3.3 and 3.4 for the remaining two 26” blocks in the assembly.

3.6 Repeat Steps 3.3 through 3.5 for the remaining 7 bays in the pontoon.

3.6.1 26” blocks on the radius side shall be chamfered to fit the contour of the hull as shown below.



3.7 Secure clamps along the edge of the mold and add temporary bracing just above the 26” foam blocks as needed to press the hull against the mold.

3.7.1 Any spreader bars or blocks and wedges shall be located in the same line on each side of the longitudinal bulkhead to ensure the bulkhead remains straight.

3.8 Place liquid foam (PFPI 9302-1.95HFC) around the perimeter of each foam assembly in 2 lifts of approximately 12”, but do not exceed the height of the 26” block.

3.8.1 Foam placed under the block along the radius side shall be monitored for any lifting of the block.

3.9 After the foam is sufficiently cured, remove the temporary bracing and stack the remaining 4” foam blocks (PN 2 & 3) as shown in Drawing 8420-9.

3.10 Temporarily pin the 4” blocks to each other and the 26” block using (2) 10” TimberLok hex head screws per beveled 4” piece (PN 3).

3.11 Foam the remaining gap around the blocks up to the top of the hull.

3.12 Strike any excess foam once fully cured by cutting or sanding until it is even with the foam blocks and remove TimberLok screws.

3.13 Add a tapered block of foam at each end of the beveled recess a distance of 15-1/2” from each bulkhead where the stiffener stops short.

ELFOAM® P200

Polyisocyanurate Foam

April 2012

Product Description

ELFOAM P200 is a 2.0 lb/ft^3 (32 kg/m^3), rigid, unfaced, closed cell polyisocyanurate foam supplied as blocks, sheets, shapes and custom parts for a variety of insulation, core material and carving applications. Polyisocyanurate foam (polyiso) is similar to polyurethane foam but offers greater dimensional stability over a wider service temperature range.

ELFOAM P200 is manufactured in bunstock form 26″ (66cm) thick with a 48″ (122cm) width in 72″, 96″, 108″, 120″, and 144″ (183cm, 244cm, 274cm, 305cm, and 396cm) lengths. Cut sheets are offered in thicknesses from 1/8″ to 12″ (.32cm to 30cm) in 1/32″ (.08cm) increments. Custom sizes and fabricated parts up to 26″ (66cm) thick and 192″ (488cm) in length are available for customers wanting to eliminate in-house cutting, handling, and scrap disposal. Contact the Indianapolis Sales Office for additional information.

Design Considerations

ELFOAM P200 is designed for use in environments where temperatures range from -297°F to +300°F (-183°C to +149°C). However, in non-laminated applications where P200 is exposed to temperatures exceeding 140°F (60°C) and/or relative humidity in excess of 70%, allowances for foam expansion may need to be incorporated into the engineering design. Regardless of operating conditions, a qualified design engineer should review all foam applications.

ELFOAM, like all cellular plastics, will degrade upon prolonged exposure to sunlight. Cover foam material in order to block ultraviolet radiation and prevent degradation. Other coverings to protect exposed foam surfaces from the elements and to meet applicable fire regulations may also be required.

Applications*

- Refrigerated food service equipment
- Laminated wall and roof panels
- Commercial and industrial doors
- FRP panels, tanks and shelters
- Truck/Trailer bodies, shipping containers and railcars
- Pipe, tank and vessel insulation
- Plugs, patterns and carved products

Environmental Data

ELFOAM P200 is specifically formulated to provide excellent physical properties without the use of chlorofluorocarbon (CFC) or hydrochlorofluorocarbon (HCFC) blowing agents. In compliance with the Montreal Protocol and the Clean Air Act, ELFOAM P200 is manufactured with hydrocarbon blowing agents which have no ozone depletion and no global warming potential.

Safety

All persons who work with ELFOAM products should follow proper handling procedures. The ELFOAM Material Safety Data Sheet (MSDS) contains information on the proper handling, storage and use of this material. A copy of this MSDS may be downloaded at elliottfoam.com or obtained by calling the Indianapolis Sales Office.

Availability

All ELFOAM product support, samples, pricing and orders are coordinated by the Indianapolis Sales Office. Please call (800) 545-1213 for details. Additional ELFOAM product data sheets may also be downloaded at elliottfoam.com.

* Application testing is often required to determine suitability of the foam for a specific application. The potential user should perform pertinent testing to determine the suitability of the product for the intended application. Final determination of fitness of the product for any particular use is the responsibility of the buyer.

NOTE: Elliott Company of Indianapolis Inc. (Elliott) believes the information and recommendations herein to be accurate and reliable as of date of publication. However, since any assistance furnished by Elliott with reference to the proper use and disposal of its products is provided without charge and since use conditions are not within its control, Elliott assumes no obligation or liability for such assistance. No warranty, expressed or implied, regarding accuracy or correctness is given and Elliott expressly disclaims any implied warranties including the implied warranties of merchantability or fitness for a particular use. Since use conditions and government regulations may vary from one location to another and may change with time, it is the buyer's responsibility to determine whether Elliott products are appropriate for buyer's use, and to assure the buyer's workplace and disposal procedures are in compliance with law, regulations, ordinances, and other government enactments applicable in the jurisdiction having authority over the buyer's operations.

Family Owned since 1957

ELLIOTT® COMPANY OF INDIANAPOLIS INC.

Manufacturer/Fabricator of ELFOAM Polyiso & Polyurethane Products

ELFOAM® P200 Polyisocyanurate Foam April 2012

Product Description

ELFOAM P200 is a rigid, unfaced, closed cell polyisocyanurate (*polyiso*) foam material. This CFC and HCFC free product provides outstanding physical properties at service temperature environments from -297°F to +300°F (-183°C to 149°C). ELFOAM P200 is supplied in standard and custom blocks, sheets and fabricated shapes.

Physical Properties (1)(2)(3)	ASTM Method	Typical Values (4) English	Metric
Density	D1622	2.0 lb/ft³	32 kg/m³
k-factor(5)	C518		
Initial at 75°F (24°C)		0.165 BTU•in/hr•ft²•°F	.024 W/m•°C
Aged 10 days at 158°F (70°C)		0.185 BTU•in/hr•ft²•°F	.027 W/m•°C
R-value/inch	C518		
Initial at 75°F (24°C)		6.0 Hr•ft²•°F/BTU	1.06 m²•°C/W
Aged 10 days at 158°F (70°C)		5.4 Hr•ft²•°F/BTU	0.96 m²•°C/W
Compressive Strength	D1621		
Parallel		27 lb/in²	186 kPa
Perpendicular, min		18 lb/in²	124 kPa
Compressive Modulus	D1621		
Parallel		700 lb/in²	4,823 kPa
Perpendicular, min		334 lb/in²	2,301 kPa
Shear Strength	C273		
Parallel		22 lb/in²	151 kPa
Perpendicular, min		16 lb/in²	110 kPa
Shear Modulus	C273		
Parallel		220 lb/in²	1,516 kPa
Perpendicular, min		177 lb/in²	1,219 kPa
Tensile Strength	D1623		
Parallel		41 lb/in²	283 kPa
Perpendicular, min		26 lb/in²	179 kPa
Tensile Modulus	D1623		
Parallel		1,225 lb/in²	8,440 kPa
Perpendicular, min		463 lb/in²	3,190 kPa
Closed Cell Content(6)	D2856	92%	
Water Absorption (by volume)	C272	1.27%	
Water Vapor Transmission	E96	4.0 perms/in	7.0 ng/Pa•S•m
Dimensional Stability (volume change)	D2126		
158°F (70°C) + 97% R.H./7 days		+3.0%	
212°F (100°C) + Ambient R.H./7 days		+1.0%	
-40°F (-40°C) + Ambient R.H./7 days		- 0.5%	
Surface Burning Characteristics(7)	E84		
Flame Spread up to 6" (15.23 cm) .		<25	
Smoke Developed up to 6" (15.23 cm)		<185	

(1) Data shown are average values obtained from representative production samples, unless otherwise indicated.
(2) The suitability of this product for any particular application is the responsibility of the user. The potential user is responsible for performing any pertinent test required to determine the product's suitability for the intended application.
(3) All properties measured at 74°F (23°C) unless otherwise indicated.
(4) To be used only as a guide for engineering.
(5) k-factors will vary with age and use conditions.
(6) Freeze-thaw cycling in wet environments may cause destruction of unprotected foam's closed cell structure, resulting in the deterioration of physical properties.
(7) Numerical "Flame Spread" and "Smoke Developed" ratings are not intended to reflect hazards presented by this or any other material under actual fire conditions. This material is combustible and will burn when exposed to large fire sources.

NOTE: The information presented herein is offered is good faith as accurate, but without warranty, expresses or implied, regarding accuracy or correctness. Conditions of use and suitability of the product for particular uses are beyond the control of Elliott Company of Indianapolis Inc., therefore all risks of the use of this product are assumed by the user.

FOR MORE INFORMATION OR PRODUCT SAMPLES CALL

1-800-545-1213

OR VISIT

elliottfoam.com

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ELLIOTT® COMPANY OF INDIANAPOLIS INC.

9200 Zionsville Road Indianapolis, Indiana 46268
Phone: (317) 291-1213 • Fax: (317) 291-1219

Floating Section Length Procedure

Prepared by:

Jacob Marquis

Kenway Corporation

August 5, 2014

1.0 Purpose

This procedure documents the process for ensuring that the overall length of the floating section is within the specified tolerance when corrected to a baseline temperature of 40°F.

2.0 Safety

2.1 Follow approved lifting and handling procedures when moving and aligning pontoons.

2.2 Wear proper PPE when working around suspended loads.

3.0 Execution

3.1 The overall length of the floating section from centerline of the bearing shelf to centerline of the opposite bearing shelf shall be 3,098 in. (258’-2”) at 40°F.

3.1.1 Actual measurements shall be corrected using the following formula:

$\Delta L = L\alpha(40 - T)$, where

L = length measured at ambient temperature (in.),

α = coefficient of thermal expansion (CTE), and

T = ambient temperature (°F) at time of measurement.

3.1.2 The measured CTE, α, for the specified laminate is 8.76 in/in/°Fx10^{-6}.

3.2 The following table provides design dimensions at 40°F for key locations along the floating span length.

Location	Distance (in.)	Cumulative (in.)
Bearing centerline to face of end bulkhead	13	13
Face of end bulkhead to end of Raft 1	606	619
Spacing between Rafts 1 and 2	6	625
Overall length of Raft 2	612	1,237
Spacing between Rafts 2 and 3	6	1,243
Overall length of Raft 3	612	1,855
Spacing between Rafts 3 and 4	6	1,861
Overall length of Raft 4	612	2,473
Spacing between Rafts 4 and 5	6	2,479
End of Raft 5 to face of end bulkhead	606	3,085
Face of end bulkhead to bearing centerline	13	3,098

3.3 Mount the bearing shelf so that the centerline of the rectangular tube is 13-1/4 in. from the face of the end bulkhead on Raft 1.

3.3.1 This extra 1/4 in. will start to make up for Raft 1 being about 5/8 in. too short.

3.3.2 The 1/4 in. offset will be achieved by shifting the holes in the tube 1/8 in. toward the raft and the holes in the support plates 1/8 in. toward the tube.

Note: changes to component spacing should be made such that the distance from bolt hole center to edge of part is not reduced by more than 1/8 in., which is the existing tolerance on hole placement.

3.3.3 No temperature compensation is included for this measurement since even a 40 degree swing over 13 in. results in less than 0.005 in. change in length.

3.4 Establish the temperature corrected distance between Raft 1 end bulkhead face and end of Raft 1.

3.4.1 Record the distance and ambient temperature in the spreadsheet shown on page 3.

3.4.2 The spreadsheet will automatically generate the corrected distance at 40°F.

3.5 Increase the spacing between Raft 1 and Raft 2 by 1/4 in. to make up for more of the deviation in the desired length of Raft 1.

3.5.1 It is already known that Raft 1 is approximately 5/8 in. too short – future rafts are expected to be within ±1/8 in. of temperature corrected length.

3.5.2 A 1/4 in. adjustment shall be achieved by shifting the bolt holes in each flange 1/8 in. closer to the end of the part.

3.6 Track the cumulative distance from raft to raft as the assembly progresses and make any additional changes to pontoon length or spacing required to achieve the ±1/2 in. tolerance for overall floating section length.

Location	Distance @40F (in.)	Cumulative @40F (in.)	Distance @T_a (in.)	T_a (°F)	Corrected Dist. (in.)	Cumul. Corr. Dist. (in.)
Bearing centerline to face of end bulkhead	13	13	13.25	75	13.25	13.25
Face of end bulkhead to end of Raft 1	606	619	605.50	70	605.31	618.56
Spacing between Rafts 1 and 2	6	625	6.25	77	6.25	624.81
Overall length of Raft 2	612	1,237	611.94	80	611.75	1236.56
Spacing between Rafts 2 and 3	6	1,243	6.25	78	6.25	1242.81
Overall length of Raft 3	612	1,855	611.94	82	611.69	1854.50
Spacing between Rafts 3 and 4	6	1,861	6.25	77	6.25	1860.75
Overall length of Raft 4	612	2,473	611.94	79	611.75	2472.50
Spacing between Rafts 4 and 5	6	2,479	6.25	78	6.25	2478.75
End of Raft 5 to face of end bulkhead	606	3,085	606.06	73	605.88	3084.63
Face of end bulkhead to bearing centerline	13	3,098	13.25	74	13.25	**3097.88**
					Upper limit =	3098.5
					Lower limit =	3097.5

FRP CTE = 8.76E-06 in/in/°F

Sample Completed Worksheet for Tracking Temperature Corrected Floating Span Length